

NASA EDUCATION FORUM AT SAO ON THE STRUCTURE AND EVOLUTION OF THE UNIVERSE

NCC5-261

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# ***Annual Report***

Period of Performance January 2003 through January 2003

The NASA Education Forum at SAO  
on the Structure and Evolution of the Universe  
Grant Number NCC5-261

## ***Introduction.***

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### **Statement of Need**

NASA's Structure and Evolution of the Universe (SEU) science theme offers an unparalleled opportunity to capture the public's imagination and inspire the next generation of scientific explorers—the generation that will determine America's lead in science and technology in the 21st century. The missions and research programs of SEU science are transporting the public to some of the universe's most exotic destinations: the beginning of time, the edge of space at the entrance to a black hole, and the great cycles of matter and energy that have slowly brought life to the universe.

The public demand to participate in this adventure is evident from the many popular books, articles, movies, and exhibits on the SEU theme. A single television show on the accelerating universe, for example, recently attracted more than 2 million viewers—almost as many Americans as watch all cable news networks combined. And three leading newspapers carried more than 27 news stories about the discoveries of a single SEU mission, the Chandra X-ray Observatory.

But if future generations are to appreciate NASA's efforts in space—and to support it, and to participate in it—then we must continue to foster scientific literacy and a passion for space science.

NASA's Office of Space Science (OSS) has put in place an Education and Public Outreach (EPO) initiative designed to do just that. Spanning all of NASA's OSS science themes, the initiative is a far-reaching partnership with the education community. As a result, NASA space science now reaches every avenue of education—from the nation's schools, science museums and planetariums, to libraries, community groups and after-school programs.

As a partner in this enterprise, the SEU Forum has successfully brought SEU science to a large and diverse audience. But this is an ongoing process, and much still needs to be done. Working with our colleagues in the OSS Support Network, and with our partners in the space science and education communities, we look forward to ensuring that the public supports and participates in the great explorations of the SEU theme.

### **Goals**

Working with the SEU missions and members of the OSS Support Network, the Forum will harness the assets of the SEU science community to:

- Inform, inspire, and involve the public in the explorations of the SEU science theme.
- Use the unique resources of the SEU science theme to enhance K-14 science, technology, and mathematics education.
- Identify and develop high-leverage opportunities for the SEU science community to contribute to education and outreach.

## Guiding Principles.

The SEU Forum's work will be guided by several key principles:

- **Meet users' needs.** Research, understand, and strive to fulfill the needs of our audiences.
- **Build on existing resources.** Coordinate with programs from the NASA OSS missions and Support Network, the Office of Education and other enterprises, and organizations beyond NASA.
- **Incorporate best practices.** Maintain a solid educational foundation, based on prior research and development, for all products and programs.
- **Seek national scope.** Maintain partners with national reach and replicate successful local projects nationally.
- **Engage diverse audiences.** Strive to reach the broadest possible audience in terms meaningful to them.
- **Communicate widely.** Engage partners at the earliest opportunity, and share results broadly.

## Background: Stage 1 Accomplishments.

### *Formal Science Education.*

The Forum had made progress across the entire spectrum of science education, including educational research, curriculum development, media production, professional development for teachers, assessment, and work at the systemic level. These accomplishments have laid a firm foundation for our future activities.

Classroom demonstrations can often introduce unintended views about the universe's structure.



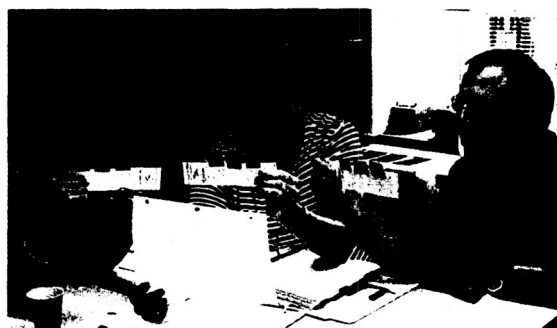
### ***In Focus:***

#### **Online Telescopes and the SEU Theme**

The MicroObservatory global network of five educational telescopes is a powerful way to bring space science to the classroom. Students and teachers *directly* control the telescopes over the Internet, selecting the target, exposure time, filters, and other factors.

Student ownership of their images, in visible wavelengths, has proven a powerful motivation to study the universe at wavelengths beyond the visible. For example, in an exploration on black holes, students used the NASA-SAO telescope site at Mt. Stromlo Observatory, Australia to image the active galaxy, Centaurus-A, then combined their images with Chandra- and radio-images of the galaxy.

Plans are underway to scale up the network so that every middle-school student in America has on-demand access, and to partner with related projects, such as the Goldstone Apple Valley Radio Telescope (GAVRT) project.



Teachers from North Carolina participate in a week-long workshop to develop and assess activities with online telescopes for the SEU theme.

*We researched public understanding of the SEU theme and identified common misconceptions that are barriers to future learning.*

- **Misconceptions about the structure of the universe.**

Through front-end evaluations, surveys, and workshops, we documented many misconceptions about the structure of the Classroom demonstrations can often introduce unintended views about the universe's structure.

universe. For example, many science teachers believe that the galaxies in the universe all lie on a sphere. We traced this misconception to its sources, including a common demonstration showing galaxies on the surface of an expanding balloon. Such research enables us to better guide the development of educational materials.

*We developed resources that address high-priority needs in the pre-college classroom.*

- **SEU Activities for Student-Controlled Online Telescopes.**

We developed curriculum modules on SEU themes, for use with a global network of educational telescopes, currently accessed by classrooms in 21 states. Some of the modules break new ground in addressing the education standards. For example, in an exploration of the expanding universe, students work with NASA's Extragalactic Database

and with their own images of galaxies to directly model the expansion of the universe. Last year, students and teachers took more than 30,000 images for their projects (see box at right). Preliminary results from assessments showed that students achieved significant gains in understanding light and color; in scientific inquiry skills; and in math skills. Teachers' classroom practice also showed gains, including much greater use of inquiry-driven activities, in which the teachers served as mentor.

- **Cosmic Survey Teaching Tool**

Used in schools from Maine to Hawaii, the "Cosmic Survey" activity promotes classroom discussion about the size, scale, and age of objects in the universe, while allowing teachers to assess students' prior knowledge.

The resource was recently adopted by the National Air and Space Museum for use with school groups visiting its *Explore the Universe* exhibit.

- **Galaxy Speed Activity**

Developed in partnership with SEU scientists, this interactive teaching tool helps students explore how astronomers determine how fast galaxies are approaching or receding. The tool was modeled successfully in workshops at the National Science Teachers' Association (NSTA) conference.

*We helped to promote and disseminate education resources and materials from the Forum and SEU missions.*

- **Professional development workshops at the NSTA**

We coordinated and hosted workshops at meetings of the National Science Teachers' Association, with the participation of the SEU missions. These workshops provided an opportunity to demonstrate how SEU-theme materials can advance teachers' classroom goals.

- **Passport to Knowledge Programs**

The Forum facilitated two programs in this popular classroom series: "Live From a Black Hole" and "Live From the Edge of the Universe." We provided technical and educational guidance; facilitated contacts with SEU scientists; produced additional animation for the shows; and facilitated the participation of several SEU missions. The two programs reached an estimated 5 million children.

- **What's Up in the Universe? Videos**

This 6-part educational video series is being produced for classroom use by an award-winning collaboration between the Institute for Astronomy, the Film Arts Foundation, and KCST-TV in Seattle. The Forum provided support and technical guidance for the series, and facilitated the participation of scientists in the programs. An excerpt from the first episode was used in the Forum's *Cosmic Questions* traveling exhibition.

*We worked at the systemic level to learn about, and help resolve, issues concerning space science in the classroom.*

- **Partnership with Boston Public School System**

We began a collaboration with the Boston Public School System, designed to improve the quality of science education and achievement in the schools, through the appropriate use of NASA's educational resources. Through meetings with the director for professional development and with other administrators, we laid the foundation for an ongoing partnership to strengthen the teaching of space science at the middle school level. Our

partnership is intended to serve as a model that can be replicated elsewhere, and our participation in the Support Network's Urban Initiatives working group will help us communicate our results widely..

- **Working with school superintendents**

We presented annual workshops on space science to superintendents from 13 school districts in Massachusetts. These high-leverage workshops were an opportunity to promote the importance of astronomy and space science in the classroom, as well as to hear from administrators on issues of concern where NASA's resources can help.

## ***Informal Science Education.***

- **National Traveling Exhibition: *Cosmic Questions***

In partnership with SEU scientists at NASA Centers and universities across the country, we produced and premiered *Cosmic Questions*, a 5000 sq.-ft exhibition that travels nationally through 2005 and is expected to be visited by more than 3 million people in 10 cities.

The exhibition focuses on both ground-based and space-based astronomy, with emphasis on the "invisible universe" and current cosmic mysteries. Visitors can explore the multi-wavelength sky, "meet" with astronomers from the Chandra Control Center, experiment with infra-red light, pilot a spaceship on a fantasy-adventure to a black hole, and fly through the universe.

Portions of the exhibition are already being replicated or adapted by other museums, including the National Air and Space Museum and the New York Hall of Science. As the exhibit travels, it will be a venue for demonstrations, lectures, and other live events by members of the space science community.

- **Planetarium Show: *Journey to the Edge of Space and Time!***



**Left:** "To truly make an apple pie from scratch, first you have to invent the universe." The Cosmic Kitchen animated theater set takes visitors young and old on a 10-minute adventure from Big Bang to apple pie. **Right:** Visitors "meet the observers" at the Chandra Control Center and explore what it's like to be an astronomer.

The Universe Forum team co-produced, with the Boston Museum of Science and with input from SEU missions, *Journey to the Edge of Space and Time*, a planetarium show on cosmology, black holes, and dark matter. *Journey* features a live update segment on SEU missions in the news, such as RXTE, Chandra, and MAP. The show increased attendance by more than 20% above normal at both the Franklin Institute in Philadelphia and at the Hayden Planetarium in Boston, where it has been seen by more than 100,000 visitors. The show is distributed nationally by SkySkan Inc., and is still in planetariums.

- **Space Science Portal: Informal Science Education Website**

With the SERCH broker and input from the OSS EPO Support Network, we piloted a website that facilitates communication between science museum professionals and space scientists interested in contributing to NASA's informal science education efforts. The website is part of a broader, coordinated effort with the Support Network's working group on Museums, Science Centers and Planetariums (MSP) and with NASA's Public Affairs Office.

- **ASTC articles, workshops, keynote addresses.**

We have taken a leadership role in increasing the visibility of NASA space science at meetings of the Association of Science-Technology Centers (ASTC), the umbrella professional organization for science museums. The Forum team wrote articles and coordinated workshops and keynote addresses by NASA space scientists and worked with other members of the Support Network to ensure NASA's continuing presence at ASTC. This work has a large multiplier effect: The museum directors and program developers at these meetings bring space science to many millions of museum visitors each year.

## ***Leveraging SEU Missions' Education Programs.***

The Forum provided services that add value to the SEU missions' EPO programs. For example, we provided guidance in the planning of educational materials, calling attention to significant needs, current research, and related resources.

- **Brokering partnerships.** We extend the reach of missions' products, by alerting missions to the needs of end-users. An example is the partnership we brokered between Chandra and the International Planetarium Society, an end-user of Chandra's CD-ROMs of images. We brokered connections between the *Passport To Knowledge* series and the SWIFT, MAP, and Chandra missions.
- **Coordinating multi-mission activities.** We provide a leadership role in identifying opportunities for multi-mission collaboration. For example, we led workshops at NSTA meetings, focusing on SEU science themes, with the participation of Gravity Probe-B, Chandra, MAP, and CHIPS. At these meetings, we also disseminate folders of information, prepared for us by Sonoma State University, about the missions' EPO programs.
- **Create high-visibility outlets.** We identify and create national-scale outlets for information about the missions and for education materials from the missions. Examples are animations from RXTE, incorporated into the planetarium show, *Journey to the Edge of Space and Time*, and animations, graphics, and information about Chandra, MAP, other missions in the Space Science Update kiosk in *Cosmic Questions*.

- **Coordinate Participation in OSS Activities.** Through teleconferences and meetings, we disseminated information between the missions and OSS Support Network. We coordinated mission entries to the EDCATS system, OSS Final Report, Space Science Education Resource Catalog, and the Institute for Global Environmental Strategies (IGES) resource review.

## ***Service to the Space Science Community.***

### **Helping Scientists Contribute.**

Scientists are among NASA's most important assets. The Forum helped to implement a wide-reaching plan, developed with the OSS Support Network, that enables space scientists to contribute their expertise at all levels of education and outreach.

For example, we apprise scientists of the many categories of involvement in EPO, and we develop specific, highly leveraged opportunities for their participation. We help in the planning of the education components of their grant proposals, paying special attention to ways in which they can build on existing projects or collaborate with other scientists working on similar projects.

We tap the expertise of the space science community by recruiting scientists to review educational products and programs for the OSS Product Registry—thus helping ensure the scientific accuracy of NASA educational materials.

We involve scientists in the professional development of educators, and in outreach to the public. For example, the Forum facilitated a professional development work-shop for informal science educators at the Boston Museum of Science, which was led by space scientists from MIT, Boston University, the CfA, and elsewhere in the region. We also brought in space scientists to address national meetings of the Association of Science-Technology Centers and other professional societies.

We have taken care to involve space scientists at every stage in developing our specific products and programs. For the *Cosmic Questions* exhibit, e.g., NASA scientists served on the advisory board; provided images, artifacts, and expertise in designing exhibit components; were videotaped as "explainers" for visitors; reviewed exhibit text for accuracy; and served as role models by giving talks and demonstrations to the public.

Finally, the Forum has taken a leadership role in helping the Support Network to develop a set of guidelines designed to increase scientists' awareness of specific ways they can contribute; and to promote best practices, so that scientists can become more effective educators without having to become education experts..

### **International Space Agencies Conference.**

We brought high visibility for NASA's education programs to an international audience, by chairing the Education Panel at the International Space Agencies Conference in Washington. As a result of these efforts, NASA's OSS EPO program is likely to serve as a model for future European and Japanese efforts.